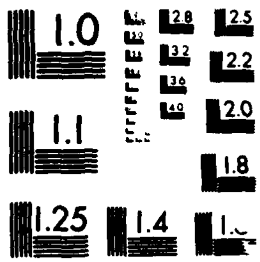
AD-A190 971 EVALUATION OF DETERMINISTIC MODELS FOR NEAR SURFACE SOIL MOISTURE PREDICTION(U) BRISTOL UNIV (ENGLAND) M G ANDERSON ET AL. AUG 87 0007 DAJA45-85-C-0007 1/1

UNCLASSIFIED F/G 8/10 NL

END



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

CONTENTS

LIST OF FIGURES

1. Objectives and Scope

The prediction of environmental factors such as soil moisture, soil strength etc., at a reasonably coarse scale (e.g. 0.2 - 25 km) with limited input data is the prime objective of this research project. This is a first attempt to be made at this scale, as previous models have tended to concentrate at the hillslope or very large scales. The main objectives have been detailed in the Third and Fifth Interim Reports, (Contract No. DAJA45-85-0007).

In this report the objectives have been further refined as follows:

(a) to develop peripheral subroutines for application of our scheme to route management problems;

(b) to set up appropriate field trials as a method of verification and validation of our scheme; and

(c) to further develop the operational aspects of the scheme with respect to problem areas where more detailed information is required than could be supplied by our scheme alone.

The scope of this report is:

(i) to detail the development of applied trafficability packages; (sections 2,3,4,and 7),

(ii) to discuss the use of "DRIVEB" as a possible validation technique, (sections 5 and 6).

Introduction

The application of the RCI prediction model to off-road trafficability studies has been extended through the development of subroutines to

(i) evaluate a given route in terms of RCI,

(ii) to select the optimum route across an area in terms of RCI and shortest distance,

(iii) to evaluate problem routes.

These applications are both dynamic through time and space and are described below.

2. Route Evaluation Package

PROCEDURE	METHODOLOGY
(a) Definition of Area	
Using soils map:	
(i) impose static grid (figure 1),	User - visual and
(ii) assess grid squares according to decision rules.	manual
Using topographic map:	
(i) evaluate areas according to a/s topographic index,	User - visual and
(ii) assess grid squares for initial moisture content based on a/s values and recent meteorological events (figure 2),	manual
(iii) assess any areas that are "no go" (figure 2).	
OUTPUT Control grid defining area (figures 1 & 2).	User - visual and manual

(b) Definition of Routes

Using the control grid identify routes to be assessed.

Define each route in terms of:

(i) every different area travelled over, (ii) *the distance the route takes over each area,* (iii) the approximate time taken over lengths of route, e.g. speed 25km hr - reasonable to require upgrade of RCI every 30 mins. i.e. every 12.5 km.	User - visual and manual
OUTPUT Trial routes on control grid (figures 1 & 2).	User - visual and manual
(c) Define control grid data (cntl.id) cntl.id files are required for each different grid square defined in (b) above, i.e. in figure 1, soil type 11 is never travelled over and therefore is not required in the route evaluation. **OUTPUT** Set of information files required for running the RCI sub-model.	User defined via subroutines for: 1.creating cntl.id 2.reading existing cntl.id 3.checking/altering 4.saving
(d) Route Assessment Input routes (as defined in (b)) to package.	User prompted via subroutines for: 1.creating routes 2.reading existing routes 3.checking/altering 4.saving routes
Run package: (i) RCI generation for each different area through time (e.g. 36 hours).	RCI sub-model

OUTPUT A series of RCI data files giving values of RCI at specified intervals of time.

(ii) Assessment of RCI over route using the RCI data files generated by the RCI sub-model. — Route assessment sub-model

OUTPUT RCI over route in graphical form, (figures 3,4 & 5). — Manual or minitab

N.B. There is the facility to incorporate the stochastic variation of the soil parameters into the package which entails repeating steps d(i) and d(ii) several times.

OUTPUT Envelope of possible RCI values over route, (figures 3,4 & 5).

Information on Major Computing Times at Present

RCI sub-model with 60s iterations.

No. hrs run	1 run	system time grid 15*15 225 runs	grid 20*20 400 runs	grid 25*25 625 runs
36	7.7s	28m 52.5s	51m 20s	1h20m 12.5s
72	15.3s	57m 22.5s	1h42m	2h39m 22.5s
120	25.6s	1h36m	2h50m 40s	4h26m 40s

STATUS OF PACKAGE

1.Operational on systime.

2.User manual - in preparation.

3.Documentation - in preparation.

3.Route Selection Package

PROCEDURE	METHODOLOGY
(a) Definition of Area	
Using soils map:	
(i) impose static grid (figure 1),	User - visual and manual
(ii) assess grid squares according to decision rules.	
Using topographic map:	
(i) evaluate areas according to a/s topographic index,	User - visual and manual
(ii) assess grid squares for initial moisture content based on a/s values and recent meteorological events (figure 2),	
(iii) assess any areas that are "no go" (figure 2).	
OUTPUT Control grid defining area (figures 1 & 2).	User - visual and manual
(b) Define control grid data (cntl.id)	User defined via subroutines for:
(i) cntl.id files are required for each different type grid square defined in (a) above.	1.creating cntl.id 2.reading existing

cntl.id
3.checking/altering
4.saving

OUTPUT Set of information files required for running the RCI sub-model.

(c) Run RCI sub-model

(i) RCI generation for each different area through time (e.g. 36 hours) — RCI sub-model

OUTPUT A series of RCI data files giving values of RCI at specified intervals of time, (figure 6).

(d) Route Selection Problem

(i) identify start and finish grid squares and number of moves in each time period, — User - promted by subroutine

(ii) identify dominant direction of travel and compare the 3 adjacent squares in that direction (figure 7),

(iii) the decision which square is 'best' for the *next move* is made on the following criteria:

1. are any of the options "no go",
2. all RCI values > max threshold are set to "go", all RCI values < min threshold set to "no go", — Route selection

3. have any options been considered before, sub-model
4. a move away from the most direct route must be an improvement of 15%,
5. if, on comparison, 2 or more options are equal, the move which takes the route closer to the most direct route is choosen.

(iv) On reaching the finish grid square the route is printed. subroutine

N.B. 1. Squares may have been previously assigned as "no go" because of topography, rivers etc. They can also be assigned as "no go" by the subroutine if the minimum threshold RCI (or less) of a particular vechicle is encountered. There will also be a threshold RCI value, above which the precise value of RCI will be unimportant - these squares are classified as "go" squares - this will eliminate unnecessary calculation at high RCI values.

2. By checking if a square has been assessed before, unnecessary loops in the route will be removed.

OUTPUT Route - given by grid square identies.

STATUS OF PACKAGE

1.Sections (a) - (c) complete.

2.Debugging (d) i-iv.

4. Problem Route Evaluation Package

Application: Where a route must go through a particular gris square, it may be advantageous to examine that square in more detail. This can be done by assessing the area using a scheme such as VSAS2 (figure 8).

PROCEDURE	METHODOLOGY
(a) <u>Definition of Area</u>	
Using soils map:	
(i) impose static grid (figure 1),	User - visual and
(ii) assess grid squares according to decision rules.	manual
Using topographic map:	
(i) evaluate areas according to a/s topographic index,	User - visual and
(ii) assess grid squares for initial moisture content based on a/s values and recent meteorological events (figure 2),	manual
(iii) assess any areas that are "no go" (figure 2).	
<u>OUTPUT</u> Control grid defining area (figures 1 & 2).	User - visual and manual
(b) <u>Definition of Routes</u>	
Using the control grid identify routes to be assessed.	
Define each route in terms of:	
(i) every different area travelled over,	
(ii) the distance the route takes over each area,	User - visual and
(iii) the approximate time taken over lengths of route, e.g. speed 25km hr - reasonable to require upgrade of RCI every 30 mins. i.e. every 12.5 km,	manual
(iv) identify any area for VSAS2 scheme.	

OUTPUT	Trial routes on control grid (figures 1 & 2).	User - visual and manual

(c) Define control grid data (cntl.id)

(i) cntl.id files are required for each different grid square defined in (b) above, i.e. in figure 1, soil type 11 is never travelled over and therefore is not required in the route evaluation,	User defined via subroutines for: 1.creating cntl.id 2.reading existing cntl.id 3.checking/altering 4.saving
(ii)create data files for use in VSAS2.	User - visual and manual

OUTPUT	Set of information files required for running the RCI sub-model and VSAS2 with linked RCI subroutine.

(d) Route Assessment

Input routes (as defined in (b)) to package.	User prompted via subroutines for: 1.creating routes 2.reading existing routes 3.checking/altering 4.saving routes

Run package:

(i)	RCI generation for each different area through time (e.g. 36 hours) except "problem" square.	RCI sub-model
(ii)	RCI generation for "problem" square	VSAS2 scheme (Berliner, Whitelaw) + RCI subroutines (Cochrane)
	Calculation of 'weighted average' for square from VSAS2 output.	User - visual and manual

<u>OUTPUT</u> A series of RCI data files giving values of RCI at specified intervals of time.

(iii)	Assessment of RCI over route using the RCI data files generated by the RCI sub-model.	Route assessment sub-model

<u>OUTPUT</u> RCI over route in graphical form, (figures 3,4 & 5). — Manual or minitab

N.B. There is the facility to incorporate the stochastic variation of the soil parameters into the package which entails repeating steps d(i),d(ii) and d(iii) several times.

<u>OUTPUT</u> Envelope of possible RCI values over route, (figures 3,4 & 5).

<u>STATUS OF PACKAGE</u>

1.Operational on systime.

2.User manual - in preparation. (VSAS2 - Whitelaw, alterations - Cochrane)

3.Documentation - in preparation. (VSAS2 - Whitelaw)

5. Field Trials On Salisbury Plain

In August a fiels trial was set up to time a tracked vehicle over three different routes (figure 9) on the SPTA area 9 decribed in Report number 0006. The vehicle was timed from a standing start, accelerating as quickly as possible to maximum speed which it maintained until past the finish marker. The driving team were the same on each run. Each route was timed five times.

The RCI over each route was +300 with the topography and vehicle information determined by RARDE. This information was subsequently used for RARDE to set up their 'DRIVEB' speed prediction model. The results from DRIVEB when compared with the time trials were found to be acceptable.

6. Use Of 'DRIVEB' As A Possible Validation Technique For Our Scheme

As an initial attempt to evaluate DRIVEB's potential for future field trials and as a validation procedure for the Bristol model, three storms were designed as input to both the SMSP and Bristol models. Results from these (figure 10) enabled each route (figure 11) to be set appropriate RCI values along its length and the speeds calculated. Results from these runs indicated that redesign of the information sent to RARDE was necessary in order to make full use of the potential of the joint schemes.

7. VSAS2

An updated version of VSAS2 has been checked and cone index subroutines added to allow the ´problem square´ (figure 8) to be considered in more detail. This facility will be used in conjunction with a weighted averaging of the RCI calculated over the area in its application in package three discussed above.

8. Conclusions

The subroutines described in this report extend the versatility and application of our scheme to applied trials (both physical and by mathematical simulation). Initial results from time trials and ´DRIVEB´ predicted speeds was found to be acceptable. Further field trials and runs of DRIVEB are planned to aid in the validation of our scheme and to aid in the further development and refinement of the route evaulation package.

9. Future Developments

(i) Redesign of information sent to RARDE w.r.t.,

(a) evaluate the sensitivity of DRIVEB to RCI,

(b) establish for various soils the RCI value at which the vehicle is no longer able to operate, and

(c) establish for various soils and RCI values the acceleration curve.

This information will allow an application to long routes to be made.

(ii) Redesign of the Bristol model to weight hydraulic conductivity according to 'a/s' values. This would help to reduce the 'convergence' after saturation or near saturation of the results in figure 9 for valley sides, bottom and top.

(iii) Evaluation/validation of the Bristol model through:

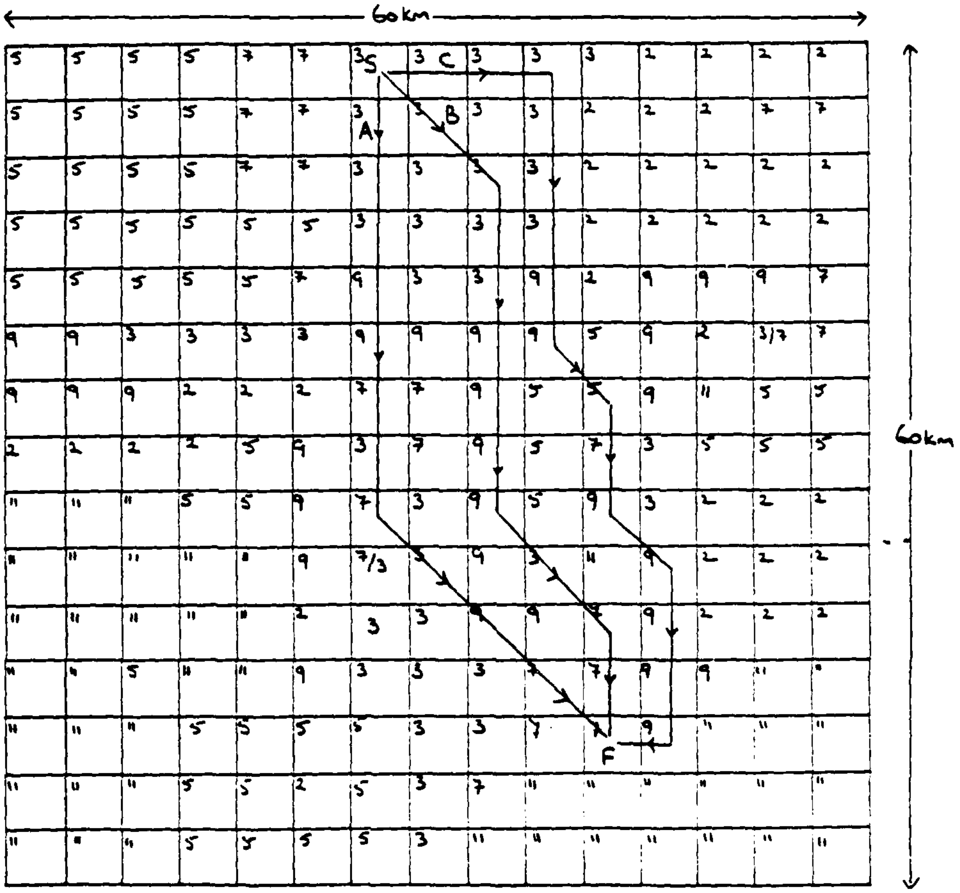
(a) DRIVEB predictions for design conditions,

(b) field trials on Salisbury Plain with a vehicle, using both predicted RCI (SMSP and Bristol models) and measured CI,

(c) measured CI with known storm characteristics at Long Ashton Research Station, Bristol.

(iv) Formulation of criteria for 'when to use which model' from a choice of SMSP or Bristol schemes.

Figure 1 Soil map with grid and potential routes.



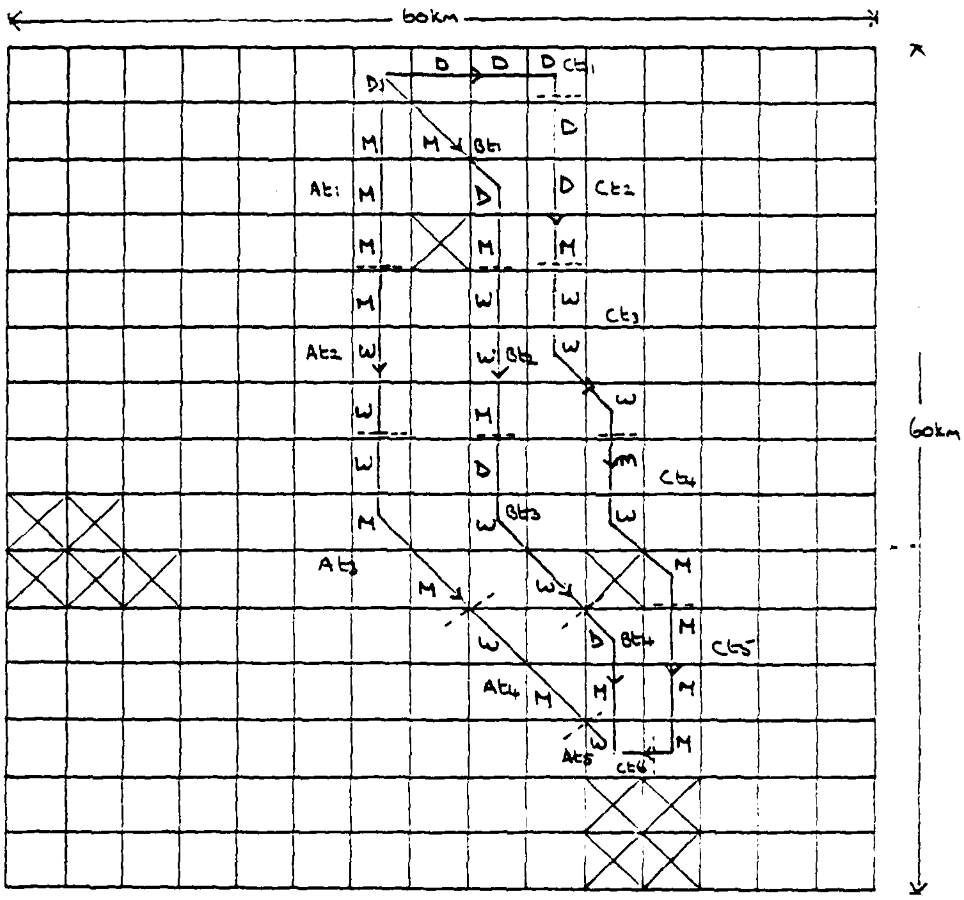
Key: soil types 2,3,5,7,9 & 11

S - start

F - finish

A,B & C - routes

Figure 2 Initial moisture conditions and "no go" areas, with 3 potential routes.



Key:

D - dry
M - medium
W - wet

} initial moisture conditions determined by a/s calculations

X - "no go" areas

At1 - route A, time period 1

Ct5 - route C, time period 5 etc.

Figure 3 RCI over route A including stochastic variability of soil parameters.

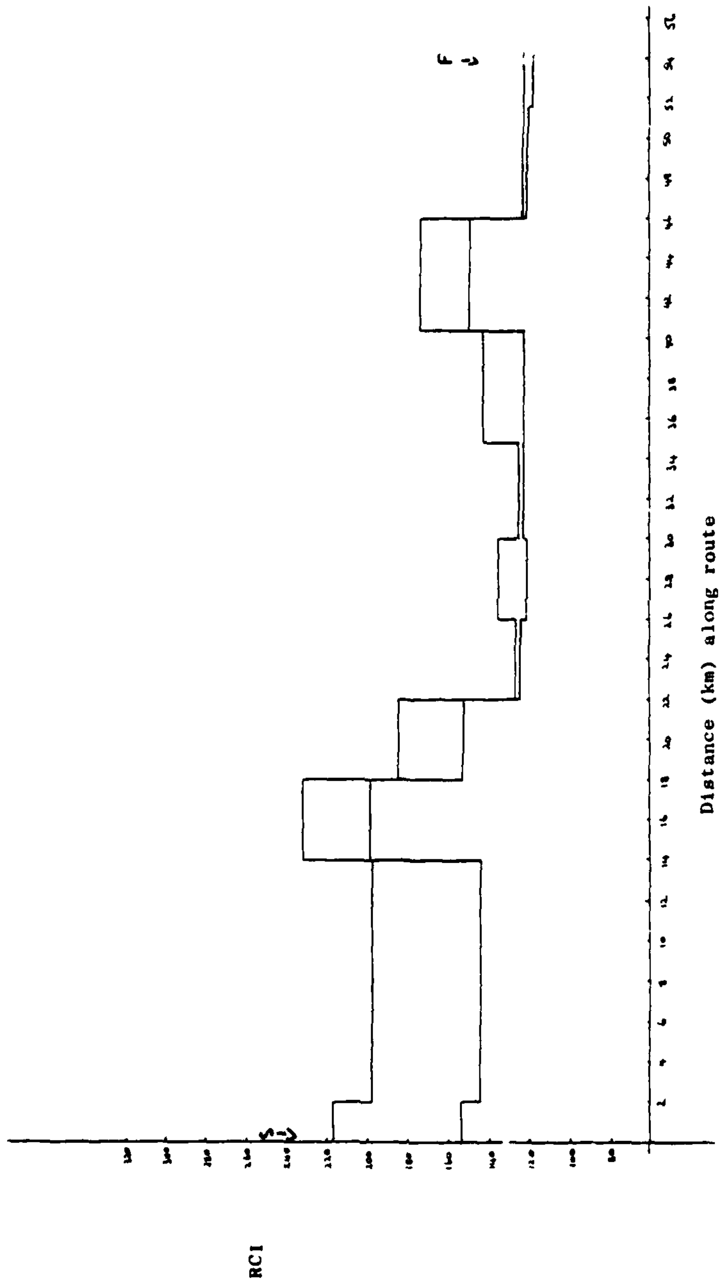


Figure 4 RCI over route B including stochastic variability of soil parameters.

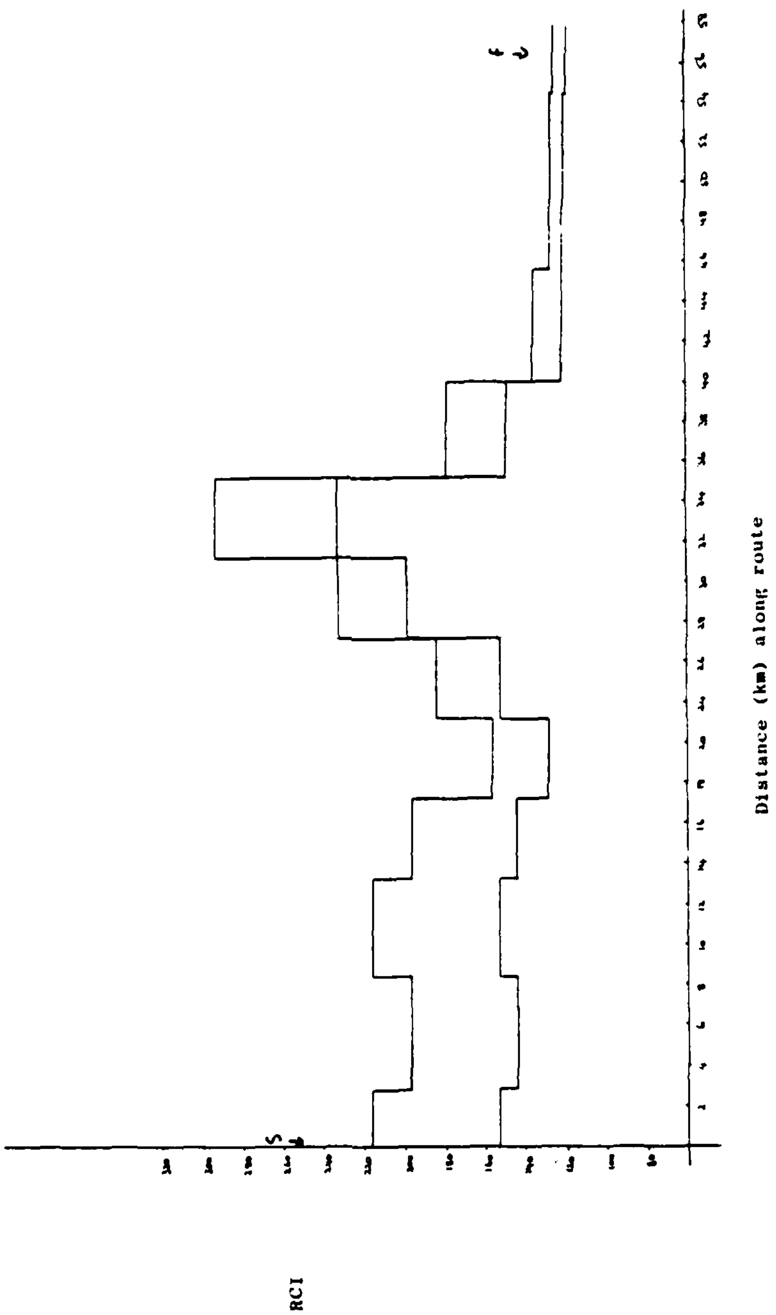


Figure 5 RCI ove route C including stochastic variability of soil parameters.

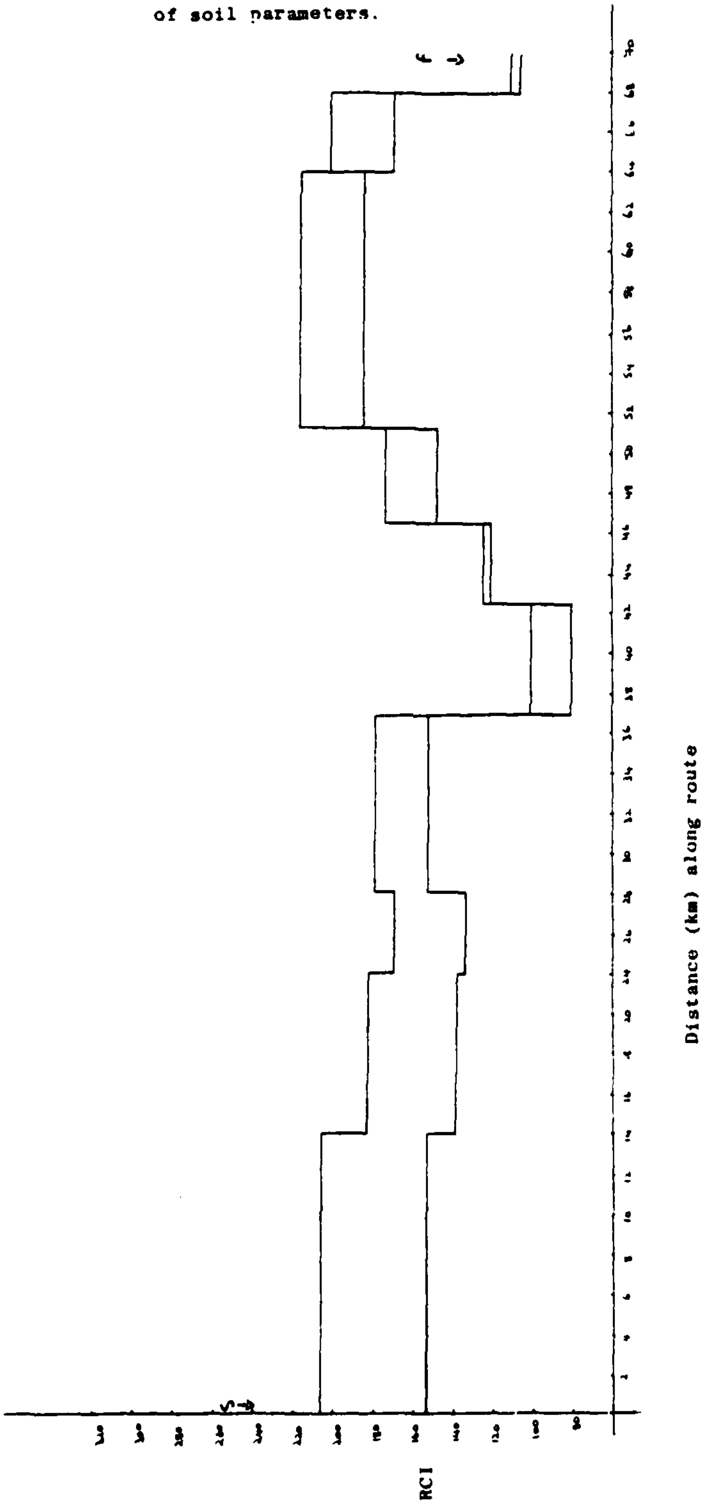


Figure 6 Library of RCI values for entire area, generated at specified time intervals.

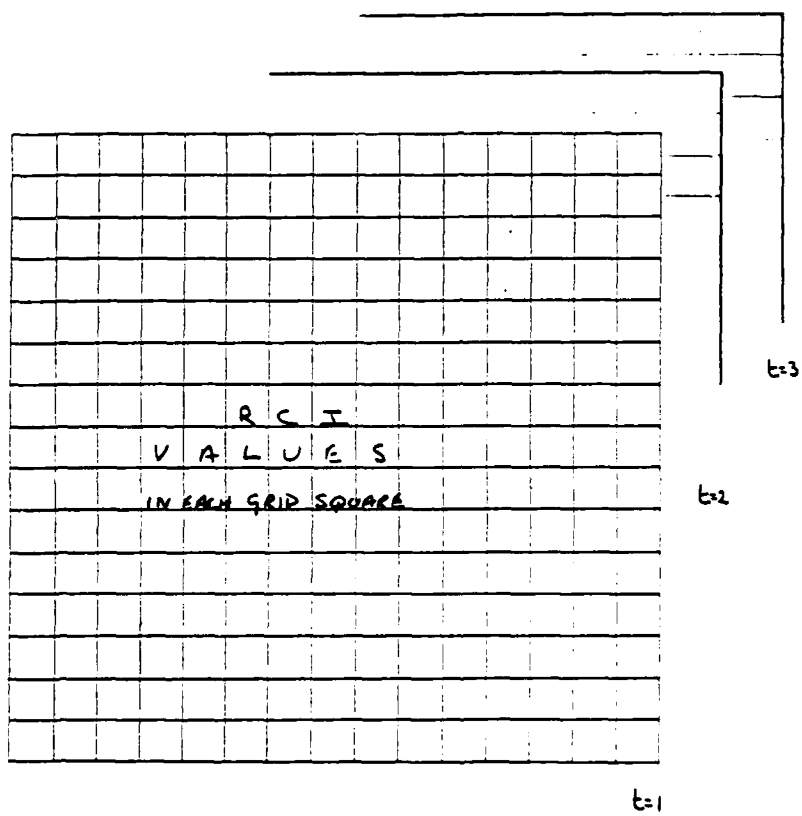
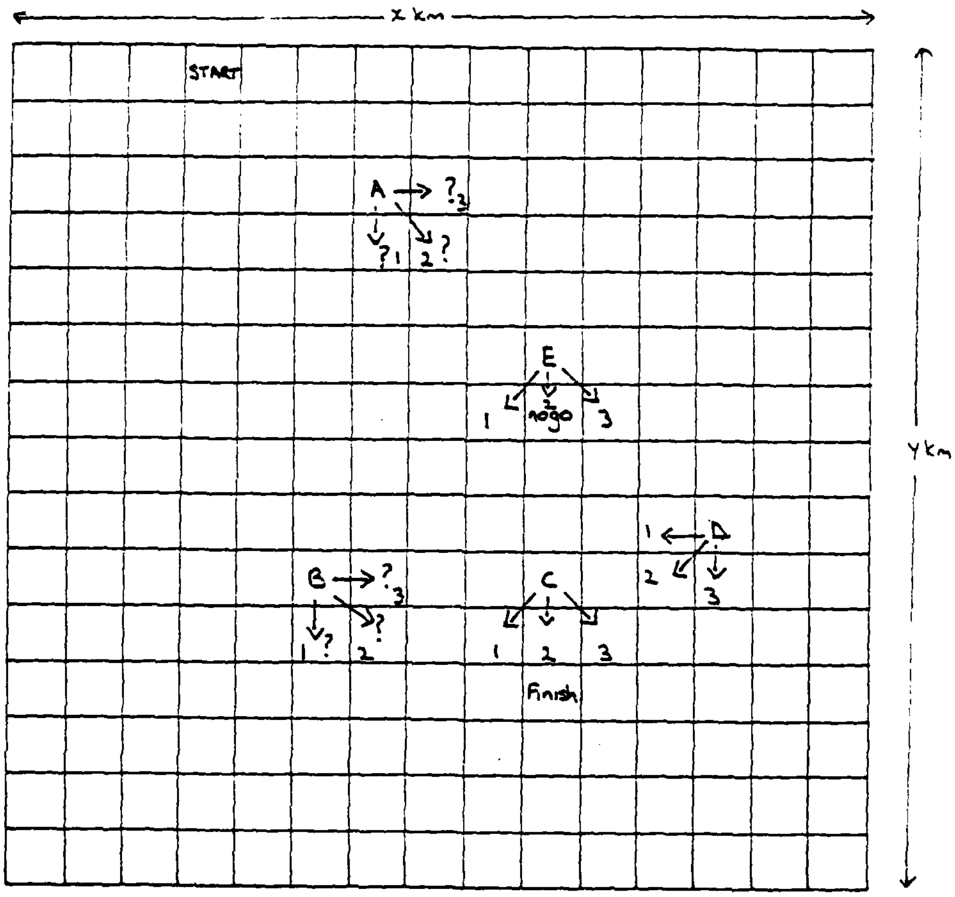


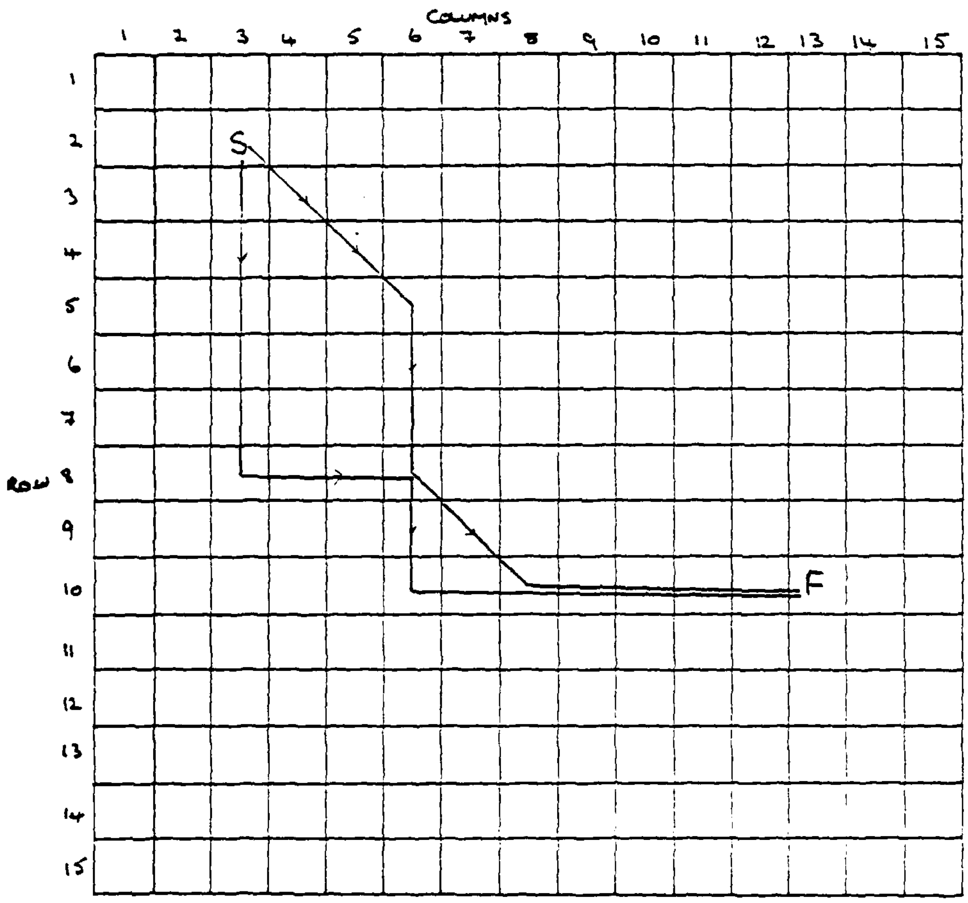
Figure 7 Decision making problem for package selected route.



Possible positions A,B,C & D with 3 options -
all options biased towards move 2.

Possible position E with 2 options -
will move to 'best' RCI value.

Figure 8 Use of VSAS2 facility.



All routes MUST go through the square with identity

column 6

row 8

Figure 9: Results from SMSP and Bristol Models.

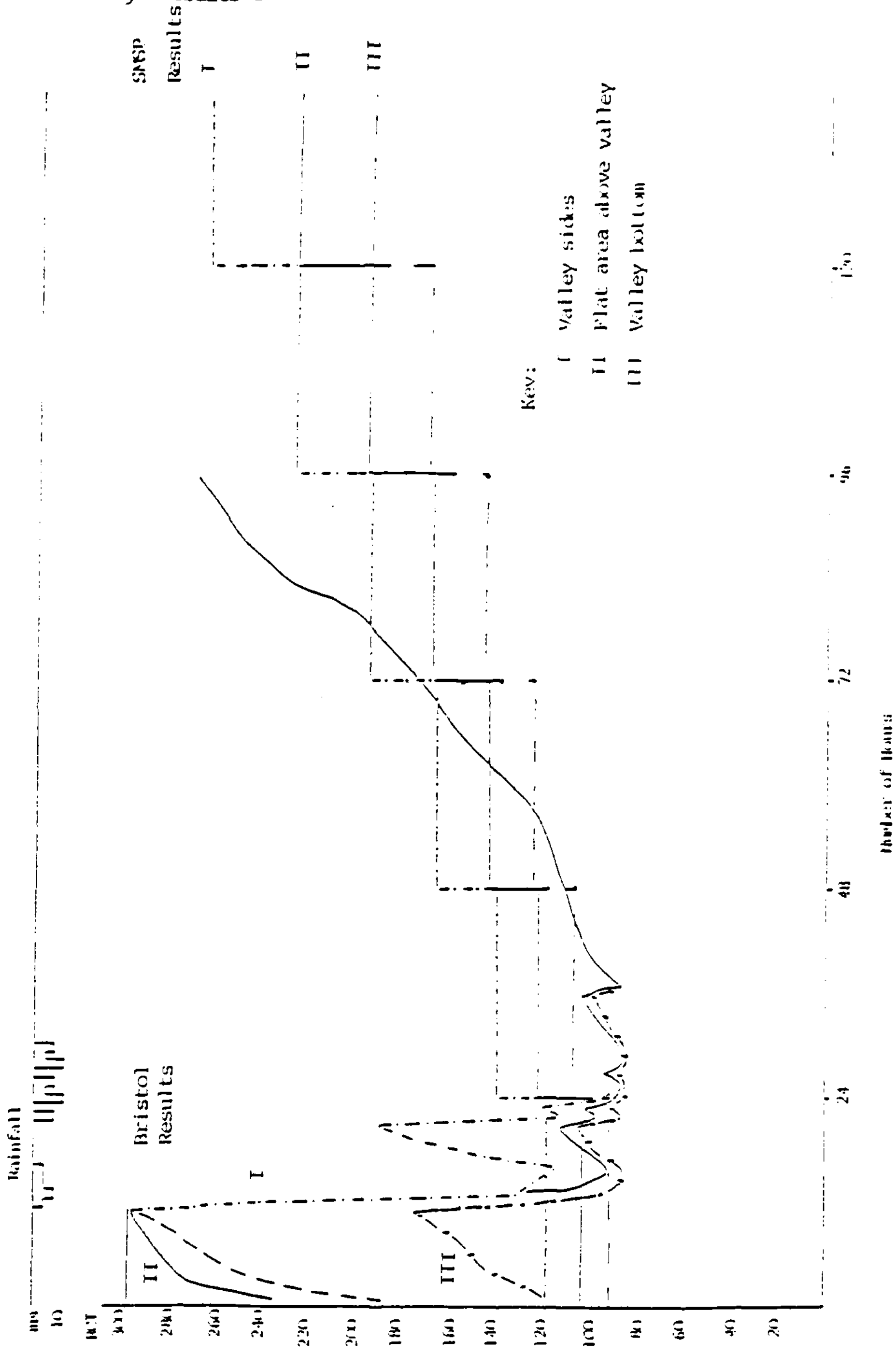


Figure 10: Routes for time trials.

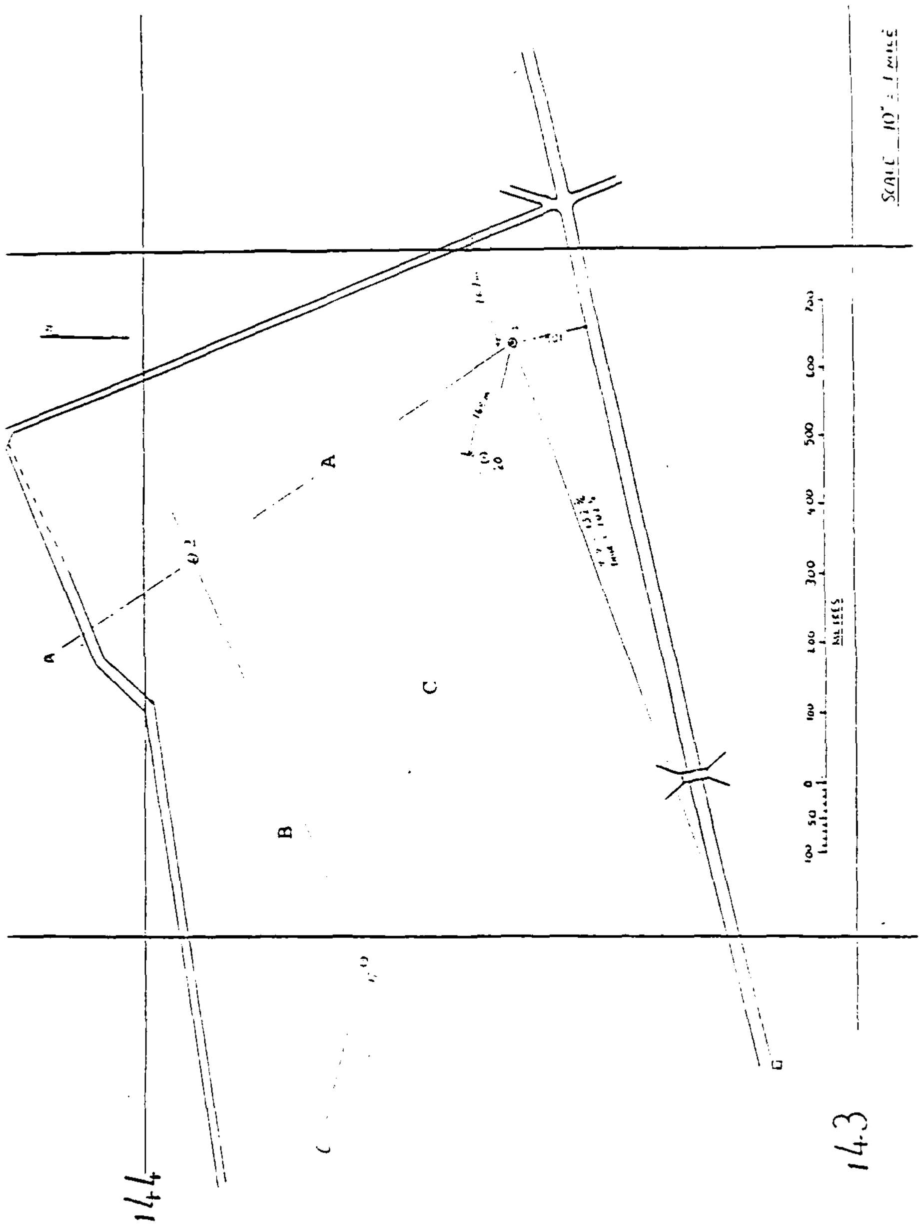
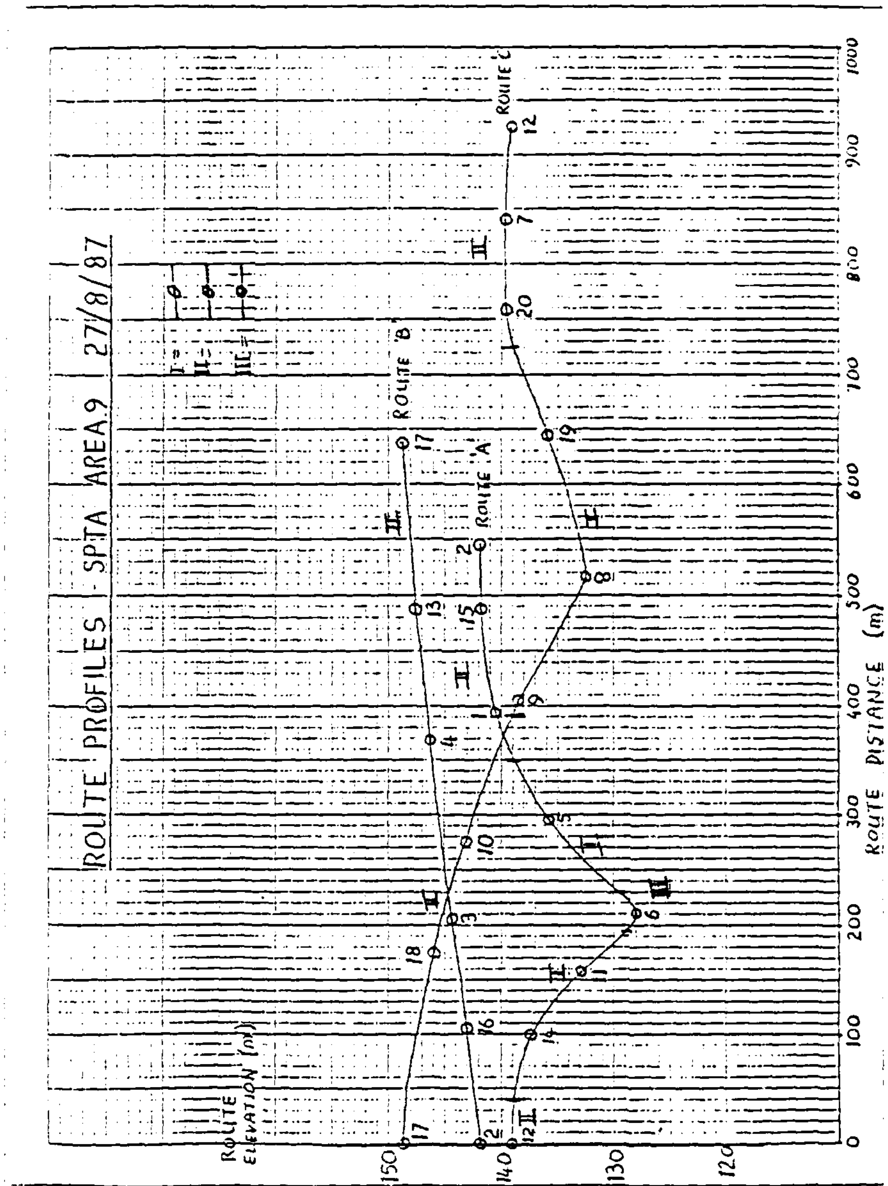


Figure 11: Route Profiles.



REFERENCES

Anderson, M.G. and J.E. Cochrane, (1986) 'Evaluation of deterministic models for near surface soil moisture prediction', U.S. Army European Research Office, London, Third Interim Report, DAJA45-85-C-0007, 100pp.

Anderson, M.G. and J.E. Cochrane, (1987) 'Evaluation of deterministic models for near surface soil moisture prediction', U.S. Army European Research Office, London, Fifth Interim Report, DAJA45-85-C-0007, 88pp.

END

DATE
FILMED

58[illegible]